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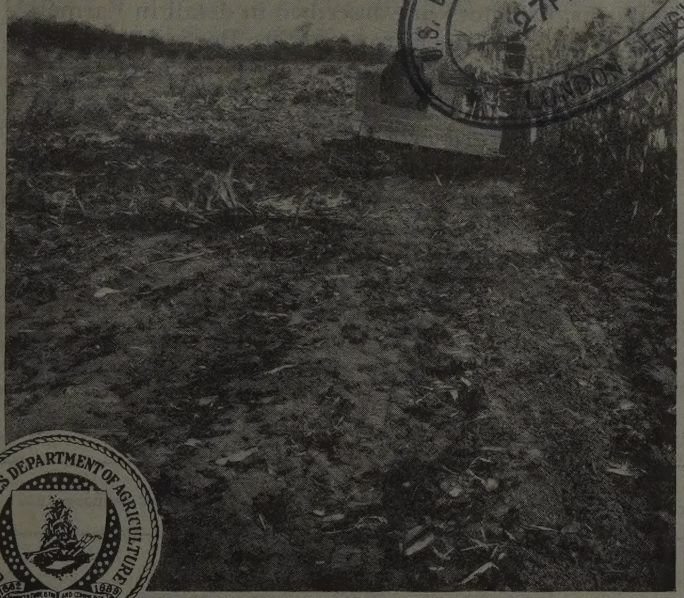
U. S. DEPARTMENT OF AGRICULTURE
FARMERS' BULLETIN No. 1562

FARM PRACTICES UNDER CORN-BORER CONDITIONS



U.S. DEPARTMENT OF AGRICULTURE
27 FEB 1928
LONDON

TO CONTROL the European corn borer and prevent serious damage to the corn crop, such as has been general in Ontario, and has occurred in limited localities in Ohio and Michigan, substantial changes in farm practices are often necessary. Under some conditions farmers in the infested areas may find it profitable to increase their acreages of crops other than corn.

This bulletin discusses the character of the problem in different parts of the infested area; indicates the control practices best adapted to different conditions; and points out the factors farmers should consider in deciding whether to reduce their corn acreage.

The methods of control discussed were all used to some extent in 1927. Those which have been found most satisfactory are described in detail in Farmers' Bulletin 1548, The European Corn Borer: Its Present Status and Methods of Control.

During 1927, information was obtained by the Bureau of Agricultural Economics, in cooperation with Ohio State University and the experiment station and extension service of Michigan, from 750 farmers in the infested areas of Ohio and Michigan on the labor and power required by different methods of control, their adaptability to particular conditions, and the influence of the borer upon the place of corn in systems of farming. This information forms the basis for many of the statements in this bulletin.

Washington, D. C. Issued January, 1928

FARM PRACTICES UNDER CORN-BORER CONDITIONS

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THE EUROPEAN CORN BORER has become well established at the edge of the Corn Belt, in northern Ohio, northeastern Indiana, and eastern Michigan. In a limited number of fields in Ohio and Michigan the borer was responsible for some commercial damage to the 1926 and 1927 corn crops. In the adjoining counties in the Province of Ontario the data of the Ontario Department of Agriculture show that the acreage of corn was reduced about 71 per cent from 1923 to 1927 on account of corn-borer damage. In 1927 slight infestations were found in eastern Corn-Belt areas considerably south and west of the 1926 infested area. (Fig. 1.) A joint committee of the American Association of Economic Entomologists, the American Society of Agronomy, and the American Society of Agricultural Engineers has expressed the opinion that "it will be impossible to eradicate the borer or even to prevent its spread to corn-growing areas not yet infested."

The continued spread of the borer in all directions, the increased infestation in most areas, and the great damage to the corn crop in Ontario all indicate that it is absolutely necessary for farmers in the infested areas to adopt farming practices which will be effective in keeping the infestation down to a minimum. The control practices which are necessary to keep the borer in check involve substantial changes in the usual methods of handling corn on Corn-Belt farms, particularly with respect to the disposal of cornstalks, stubble, or other refuse in cornfields, and the preparation of cornland for subsequent crops. These practices, for the time being at least, involve the use of additional labor and power.

In the spring of 1927, the labor used in preparing 1926 corn land for the 1927 crop in most of the corn-borer clean-up area was approximately twice the amount normally used. This was due partly to the farmers' lack of experience in performing the necessary control operations. Weather conditions were also generally unfavorable to the adoption of control practices in 1927, and under more favorable weather conditions, the control practices would not require so

large an increase in the labor and power used in preparing cornland for the following crop. Nevertheless, even with more favorable weather conditions, the extra labor involved in control practices in most of the important corn-growing areas indicates the serious

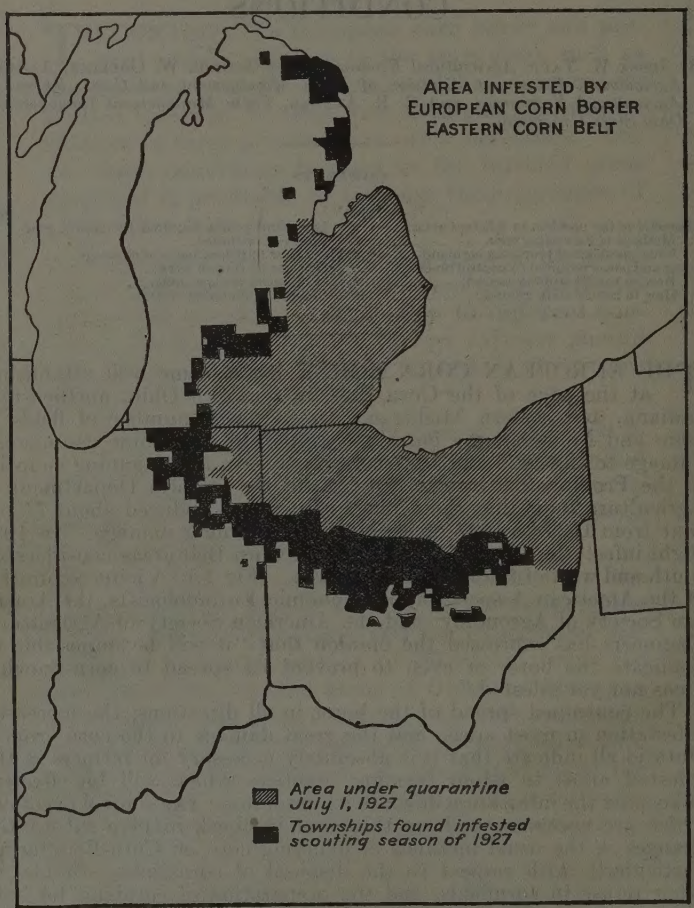
AREA INFESTED BY
EUROPEAN CORN BORER
EASTERN CORN BELT
Area under quarantine July 1, 1927
Townships found infested scouting season of 1927

FIG. 1.—Areas infested by the European corn borer in the eastern Corn Belt. Some of the townships found infested in 1927 might have been infested previously as all of them were not scouted in 1926. The borer is spreading rather rapidly, however, to the West and South. Commercial damage in this portion of the United States has been limited to a few areas near the Great Lakes in northern Ohio and eastern Michigan

nature of the new farm-management problems which farmers in the infested areas are encountering.

These new farm-management problems include questions as to (1) the most practical and economical methods of controlling the borer

which can be fitted in with present systems of farming and (2) as to the desirability of making changes in present systems of crop and livestock production on account of the new conditions under which corn must be grown. This bulletin summarizes the available information bearing upon these problems, with a view to aiding farmers in the areas now infested, and in areas likely to be infested soon, in

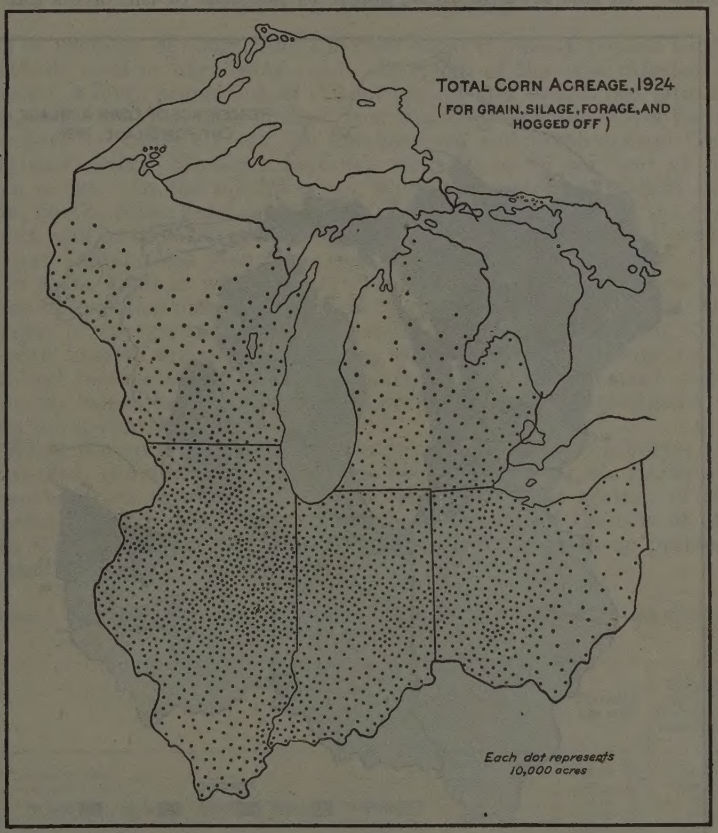

FIG. 2.—Corn acreage in the eastern Corn Belt, 1924, based on Census data. The corn borer is just beginning to reach the areas of heavy corn production in the eastern Corn Belt

determining the adjustments which they should make in farm practices and farming systems.

CHARACTER OF THE PROBLEM IN DIFFERENT AREAS

On most farms in the areas already infested, corn is the most important cultivated crop in the rotation, and is a primary source of feed for the livestock enterprises. Moreover, the borer is only beginning to reach the areas of heavy corn production. (Fig. 2.) The problems of adjusting farming practices to corn-borer conditions

obviously will be more serious as the infestation spreads and increases to the west and southwest.

Where the acreage of corn per farm is relatively small, or where a large portion of the corn is put into the silo or shredded, the problem of controlling the borer is greatly simplified. In the infested area in northeastern Ohio the acreages of corn on most farms are relatively small. In this area, in 1924, about 14 per cent of the farms had no

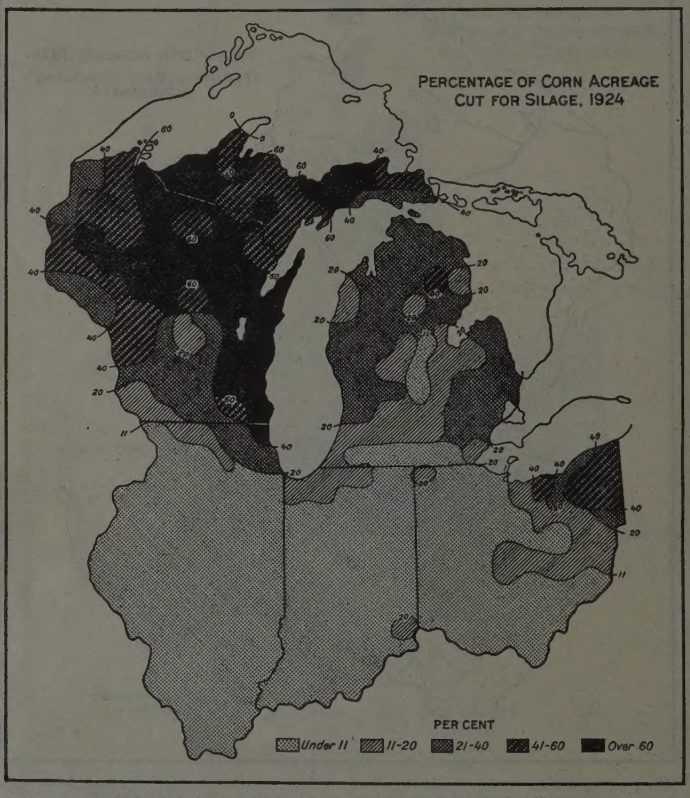

FIG. 3.—Proportion of corn put into silo in the eastern Corn Belt, 1924. Where a large part of the corn is put into the silo the problem of controlling the corn borer is greatly simplified

corn, over 50 per cent had from 1 to 10 acres per farm, and only 6 per cent of the farms had more than 20 acres. In north-central Ohio about one-third of the farms had from 11 to 20 acres of corn, in 1924, and half of the farms had over 20 acres. In the cash-grain area in northwestern Ohio and northeastern Indiana, however, over three-fourths of the farms had more than 20 acres of corn in 1924, and almost half of them had over 40 acres of corn per farm. From 11 to 20 acres of corn are most common on the farms in the north-

western corner of Ohio and in the southeastern corner of Michigan. In the northernmost portion of the 1926 infested area the corn acreages are similar to those in northeastern Ohio. In this area in 1924, about 10 per cent of the farms had no corn; 61 per cent had from 1 to 6 acres; only 29 per cent had more than 10 acres and less than 7 per cent had over 20 acres of corn per farm.

METHODS OF HARVESTING CORN

The problem of controlling the corn borer is closely related to the methods used in harvesting corn. In much of the area infested at present, a large proportion of the corn is cut and then is put into the silo, or is shredded, or is husked from the shock and the stover fed to livestock. (Table 1.) In the northeastern and north-central Ohio and east-central Michigan sections, from 80 to 95 per cent of the corn is cut. In the northwestern Ohio-southeastern Michigan section, on the other hand, only about one-third to one-half of the corn is cut, and in the cash-grain section of northwestern Ohio and northeastern Indiana less than 5 per cent of the corn is cut.

In those areas in which a large proportion of the corn is cut, the clean-up problem may be simplified by cutting the corn very near the surface of the ground, as recommended in Farmers' Bulletin 1548. If corn binders are used, difficulties are often met in attempting to cut and remove all stalks. This matter is not so important under ordinary conditions but is very important from the standpoint of corn-borer control.

When the corn goes into the silo practically all of the borers are destroyed, provided the corn is cut very low and all the stalks are removed from the field. In the northeastern Ohio portion of the present infested area, from one-fourth to one-half of the corn is put into the silo. (Fig. 3.) This greatly reduces the clean-up problem in that part of the infested area.

TABLE 1.—*Proportion of corn cut and put into silo or shredded, in selected areas in 1926 corn-borer territory*

Area	Percentage cut	Percentage put into silo or shredded
Northeastern Ohio	90 to 95	40 to 60
North-central Ohio	60 to 90	45 to 60
Northwestern Ohio and northeastern Indiana (cash-grain area)	0 to 5	0 to 5
Northwestern Ohio and southeastern Michigan	35 to 50	15 to 30
East-central Michigan	95 to 100	60 to 70

A rather large proportion of the corn in eastern Michigan is put into the silo, but only a very small part of the corn in the remainder of the infested area now goes into the silo. South and west of the present infested areas an even smaller portion of the corn is utilized in that way.

The use of the husker-shredder is a common practice on some farms in parts of the corn-borer area, particularly in northeastern and north-central Ohio and in eastern Michigan. This practice, under proper conditions, serves to destroy the corn borers in stalks, but in the more important corn-producing areas only a small part

of the acreage is handled in this way. In the cash-grain area of northwestern Ohio and northeastern Indiana, for example, only a negligible proportion of the corn is either shredded or put into the silo.

Another harvesting practice is that of hogging down corn. This practice is not so common in the present infested area but is more common in the areas just at the edge of the present infestation. The areas east of the Mississippi River, where this practice is most

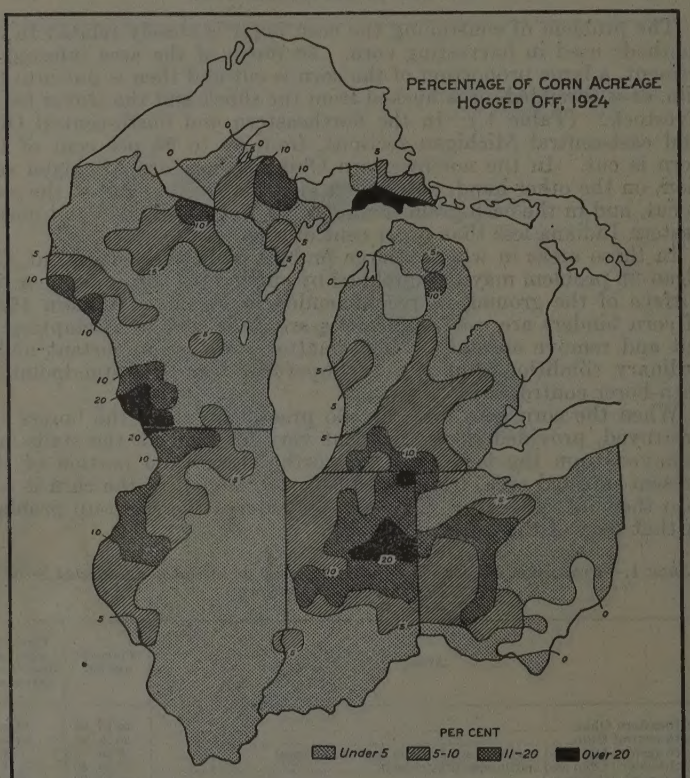

FIG. 4.—Proportion of corn harvested by hogging down, 1924. The extra work necessary for cleaning up cornstalks where the corn has been harvested by hogging down may make it necessary to abandon this practice

common, are indicated in Figure 4. This method of harvesting corn may increase the difficulty of later clean-up. The stalks are broken down in every direction, and it is more difficult either to break or cut all of them loose for raking and burning, or to plow them under.

USUAL METHODS OF PREPARING CORNLAND

The usual methods of preparing cornland for subsequent crops are not satisfactory, in most cases, from the standpoint of corn-borer

control. In order to keep the infestation down so that little or no commercial damage will result, it is necessary to destroy or to plow under, completely, all stalks or stubble before the time of the emergence of the moths. Some of the present methods of preparing cornland for other crops more nearly meet this requirement, or can be adapted to meet it more easily than can others.

In areas in which cornland ordinarily is plowed for the following crop, a slight adjustment in this operation will often be all that is necessary. The most difficult problem is found in those areas where stalk or stubble ground ordinarily is disked for a small-grain crop, and especially where soil conditions are such as to make plowing after corn a difficult practice.

In the northeastern Ohio part of the infested area practically all of the corn is ordinarily cut and much of it is shredded or put into the silo. From 80 to 90 per cent of the corn ground ordinarily is plowed for the following crop. All of these practices, with minor modifications, can be made effective measures in keeping down the corn-borer infestation in this area.

In north-central Ohio the acreage of corn per farm is considerably larger than it is farther east, and the farming systems include fewer dairy cows and more hogs and other livestock. A smaller proportion of the corn ordinarily is cut, so that more stalk ground must be prepared for the following crops. Cornland is practically all seeded to small grain. Slightly less than one-half of it is seeded to wheat in the fall, and most of the remaining acreage is seeded to oats in the spring. The cornland seeded to wheat ordinarily is disked twice before seeding in the fall, but occasionally a field is seeded with only one disking ahead of the drill. This is practically all stubble ground with a very small portion normally seeded between the rows of standing corn. Most of the stalk ground and some of the stubble ground is seeded to oats the following spring, either with or without plowing.

Ordinarily about one-third of the cornland of this section is plowed for subsequent crops. On account of the peculiar soil type over a considerable portion of this area, however, more labor often is required to get the land into condition to seed after plowing than if no plowing is done. Yields also are often lower on plowed ground. Where plowing is done, ordinarily a double disking and two harrowings, or one harrowing and one rolling after disking, are necessary to prepare the seed bed. Where the spring grain is seeded without plowing the land ordinarily is double disked and is sometimes harrowed once. On some farms stalks and stubble are broken down during the winter. Raking and burning stalks, however, were not common practices in this area before 1927, unless the corn was to be followed by corn or another cultivated crop.

Farther west, and along the Ohio-Indiana State line, lies the area of the heaviest corn production of any part of the present infested territory. Paulding County, Ohio, is typical of this area. Here practically all of the corn is husked from standing stalks, and the land is seeded to oats the following spring. Very little livestock of any kind is kept. Ordinarily none of the corn ground that is seeded to oats is plowed. It is usually not practicable to get rid of the stalks by plowing them under, because of the difficulty in getting the land into condition and because the oat yield often is reduced on plowed land. The extra labor needed for plowing large acreages delays

seeding, and such delay often causes a still further reduction in yields. Normally this land is disked once or twice and then seeded, although some is seeded with no previous preparation.

In the area which includes the northwestern corner of Ohio and the southeastern corner of Michigan approximately one-half of the cornland is plowed for the following crop, and the operations are similar to those in common use in the north-central part of Ohio. The nature of the soil makes plowing in the spring much more satisfactory than it is in the area farther south and west.

The situation in the northern part of the infested territory in east-central Michigan is similar to that in northeastern Ohio. From 75 to 90 per cent of the cornland normally is plowed for the following crop, practically all of the corn is cut, and a large part of it is put into the silo or is shredded. Hence only minor changes from present practices are needed.

LABOR AND POWER REQUIRED BY CONTROL PRACTICES

The means of controlling the corn borer, as outlined in Farmers' Bulletin 1548, include the following methods or combination of methods of disposing of infested plants:

(1) Feeding to livestock direct from the field, or as silage, or as finely cut or finely shredded material.
(2) Plowing under cleanly.
(3) Burning completely.

In selecting the most desirable method for particular circumstances, consideration must be given to the usual practices in harvesting corn and preparing cornland for another crop, the labor and equipment available, and the extra labor and additional investment involved in adopting various other methods. If plowing in the spring, following corn, is a customary practice, for example, the most practical method probably would be different from that in another section where the spring crop is usually seeded without plowing. Likewise where the corn is cut the most practical means of control is different from that where the corn is husked from the standing stalks.

HOW TO HANDLE STUBBLE GROUND

PLOWING UNDER STUBBLE

In northeastern Ohio and east-central Michigan, where most of the corn is cut, most of the stubble ground ordinarily is plowed for the next crop. In north-central Ohio, in the northwestern corner of Ohio, and in southeastern Michigan, a smaller proportion of the cornland is handled in this way. Where corn-stubble ground is plowed and the plowing is done satisfactorily, the labor required per acre for preparing the land for another crop, including the operations necessary to dispose of all stubble, would be about as follows:

	Man-hours	Horse-hours
Breaking stubble	0.5	1.0
Plowing	5.0	15.0
Disking (double)	2.0	6.0
Harrowing	.8	2.4
Rolling or dragging	.8	1.6
Total per acre	9.1	26.0

Where the plowing is done very carefully or where large plows or special attachments for covering stalks are used the stubble can be disposed of completely by these operations.

On farms where the cornland is handled in this way the only extra labor involved is that for breaking stubble before plowing, and even this operation will not be necessary if the corn is cut fairly low. If small plows are used, as on a large proportion of the farms in northeastern Ohio and east-central Michigan, it may be necessary to hand pick and burn the stubble left on the ground after the plowing and the seed-bed preparation are completed. The necessity for this work may be obviated, however, by cutting the corn as low as 2 inches. Either low cutting or more careful plowing can be substituted for most of the hand picking and burning of stubble that was done by farmers in these sections of the infested area in 1927.

The selection of the most desirable method of destroying the borer is a greater problem in areas and on farms where the stubble ground

FIG. 5.—Picking up stalks, stubble, and other trash by hand is a tedious and back-breaking job. Work of this type can usually be avoided on stubble ground either by low cutting or plowing, and on stalk ground by plowing or breaking off, raking, and burning

normally is disked in preparation for the following crop, instead of being plowed. Under these conditions the following labor per acre is ordinarily used in preparing the land:

	Man-hours	Horse-hours
Disking (double)	2.0	6.0
Harrowing or rolling	0.8	2.4
Total per acre	2.8	8.4

Several methods of modifying these practices so as to control the borer are practicable. The land can be plowed and handled in the same way as indicated above, where plowing is the customary practice. If the character of the soil is such that this can be done, this method would require a total of approximately 9.1 hours of man labor and 26 hours of horse work per acre. This amounts to about 6.3 hours of man labor and 17.6 hours of horse work per acre in addition to that required for disking and harrowing. The need for this extra labor is caused in part by the necessity for more seed-bed preparation after plowing than after disking.

BREAKING, RAKING, AND BURNING STUBBLE

One method of destroying stubble, used to some extent in 1927 on land that was not plowed, consisted of breaking, raking, hand picking, and burning the stubble and then preparing the land for seeding in the usual way. This method of handling stubble ground is not satisfactory, however, because of the difficulty of raking stubble, which makes it necessary to do much hand picking afterward. Either low cutting or plowing under are equally effective in disposing of the stubble, and they have the advantage of eliminating the back-breaking and tedious work of hand picking. (Fig. 5.)

LOW CUTTING

On some of the farms of north-central and northwestern Ohio and southeastern Michigan the character of the soil makes it impracticable to plow the cornland the following spring for a small-grain crop. The larger acreages of corn per farm also add to the difficulty of meeting the situation in this way. On farms that have 30 acres of corn (which is a common acreage on farms in this area), about 24 days of extra labor would be needed for doing the extra plowing. The most satisfactory way of reducing the extra labor on these farms is by cutting the corn as low as 2 inches, so that the land may be prepared for small grain without plowing or without a large amount of other later clean-up work. This method of handling the cornland on these farms will be more practical as a means of control than the performance of such a large amount of extra labor for plowing, or than attempting to dispose of the stubble by raking, hand picking, and burning.

USE OF STUBBLE BEATER

Still another method, where the land is not plowed, is the use of the stubble beater. The stubble beater does satisfactory work where all of the stalks are removed in cutting and the stubble is not over 10 inches in length. It is not satisfactory on unattached stubble, or on closely spaced rows, or on very rough or stony ground, or where weeds carry an important proportion of the borers. Results are more satisfactory if the beater is used in the fall than if used in the spring. On farms on which the corn acreage seems large enough to justify the investment in a stubble beater it will usually be more economical to buy a low-cutting attachment for the corn binder or a new low-cutting binder instead, and avoid the necessity for the extra operation.

HOW TO HANDLE STALK GROUND

If corn is husked or snapped from the standing stalk, clean-up operations include breaking or cutting off the stalks, raking and burning them; the use of special attachments for plows, such as wires or chains to aid in covering the stalks; and the gathering by hand of any material on top of the ground that might harbor corn borers. Careful plowing is probably even more important than where the corn has been cut. The most satisfactory means of getting rid of cornstalks is to do a good job of raking and burning. Special cornstalk rakes, with the teeth set close together and held

rigidly, are more effective for this work than is the ordinary dump rake.

PLOWING STALK GROUND

Where stalk ground is ordinarily plowed for the following crop, the labor used per acre for preparing the land, including the operations necessary to control the borer, would be about as follows:

	Man-hours	Horse-hours
Breaking stalks	0.5	1.0
Raking stalks	.7	1.4
Burning stalks	1.0	----
Plowing	5.0	15.0
Disking (double)	2.0	6.0
Harrowing	.8	2.4
Rolling	.8	1.6
Total per acre	10.8	27.4

In 1927 this method of preparing cornland for the next crop was common on farms in southeastern Michigan and in parts of north-

FIG. 6.—Stalks or stubble can be disposed of completely by careful plowing. Wires, chains, or other attachments aid in turning under all stalks and weeds

central and northwestern Ohio. The only extra operations where the stalks are ordinarily broken off before plowing are raking and burning the stalks. The labor required for these extra operations amounts to about 1.7 hours of man labor and 1.4 hours of horse work per acre.

On some farms the cornstalks ordinarily are plowed under completely, without any raking and burning beforehand. (Fig. 6.) Under such circumstances only a small amount of extra labor is necessary in meeting corn-borer control requirements. The stalks

are much more likely to cause trouble later, however, by being brought to the surface in harrowing or cultivating. Whenever possible, the culti-packer or roller should be used to a greater extent, and the harrow as little as possible, to avoid bringing to the surface the stalks which have been covered.

Where soil conditions are such that the plowing of stalk ground is the usual method of preparation for subsequent crops, the use of wide-bottom plows, together with somewhat deeper plowing, turns the stalks and trash into the bottom of the furrow more effectively, and if a chain or wires are used, practically all surface material will be covered. This is an important means of controlling the borer on open soils where the wide furrow slice can be easily worked down.

In much of the infested area—particularly the cash-grain area of northwestern Ohio and northeastern Indiana and parts of north-central Ohio and southeastern Michigan—the stalk ground ordinarily is disked for small grain. When handled in this way the time required for preparing the land under ordinary conditions is about the same as for disking stubble ground. Under these conditions more extra labor is involved in disposing of the stalks to destroy the borers. If the stalks are disposed of by breaking, raking, burning, and plowing under as outlined above, all of these operations must be performed in addition to the usual disking and harrowing. An extra harrowing or rolling may also be necessary to put the seed bed in good condition. Thus the extra labor for disposing of the stalks by this method, as contrasted with the situation where the land is usually seeded without plowing, would be about 8 man-hours and 19 horse-hours per acre.

Where wide-bottom plows can be used, some of the labor of breaking, raking, and burning stalks may be eliminated. If all of this were eliminated, however, the extra work would still amount to about 5.8 man-hours and 16.6 horse-hours per acre. On farms growing 30 to 40 acres of corn, which is common in this area, even this amount of extra labor per acre would involve from 20 to 30 days of extra man labor per farm. If the other extra operations are done in addition to the plowing, a total of from 35 to 45 days of extra man labor would be needed for cleaning up 30 to 40 acres of cornland.

BREAKING, RAKING, AND BURNING STALKS

Another method of disposing of the stalks, which was used rather extensively on stalk ground in the spring of 1927 consisted of breaking, raking, and burning the stalks, followed by the usual disking and harrowing. The labor used per acre for extra operations by this method would be about as follows:

	Man hours	Horse hours
Breaking stalks (twice over)	0.8	1.6
Raking stalks (twice over)	1.4	2.8
Burning stalks	2.0	---
Total per acre	4.2	4.4

In addition to the extra labor for breaking, raking, and burning stalks, a great deal of labor was used on some farms in the spring of 1927 for handpicking the stalks or trash not completely gathered up by the rake. This method of disposing of stalks is very expensive,

however, and every effort should be made to do the raking and burning so that hand picking will be unnecessary. (Fig. 7.) The stalks can be raked more effectively with special stalk rakes than with the ordinary dump rake. Where the special rakes are used the labor for hand picking may be avoided or greatly reduced.

At best, however, the disposal of the stalks by this method would require about 4.2 man-hours and 4.4 horse-hours per acre for breaking, raking, and burning stalks. The advantage in disposing of the stalks by this method is the fact that much of the work can be done during the late fall and winter so that the work of preparing the land and seeding spring grain may proceed about as usual. Losses

FIG. 7.—Raking and burning stalks must be done cleanly if the work is to be effective in controlling the borer. Where the land is not to be plowed afterward the stalks should be raked both ways. Special stalk rakes are much more satisfactory for this work than the ordinary rakes

through lower yields of spring grain, when seeded after plowing on certain types of soil, are also avoided. If the hand picking can be eliminated through the use of special stalk rakes the extra labor for cleaning up 30 or 40 acres of stalk ground by this method may be reduced to 15 to 20 days, most of which can ordinarily be done ahead of the rush season in the spring.

HOW TO REDUCE BARN-LOT CLEAN-UP

If the corn is cut and the whole stalks fed, those parts of stalks which are not eaten must be disposed of as completely as are the stalks which are left in the field. The borers do not live over the winter in stalks which are buried deeply in manure. The common practice in some areas, of scattering cornstalks in the pasture for livestock, or of allowing them to accumulate in barnyards or feed lots, will have to be modified if the borer infestation is to be kept down. (Fig. 8.)

In parts of the infested area in northeastern Ohio the extra labor needed for removing and disposing of stalks around barnyards and in feed lots was greater in 1927 on some farms than that needed for disposing of stubble or stalks in the field. Much of this work can be avoided by modifying the method of feeding stalks to livestock. One of the most important ways of doing this is through the greater use of silage or shredded stover on farms where the acreage of corn and numbers of livestock are sufficient to justify the expense of shredding

FIG. 8.—Stalks in feed lots or pastures must be disposed of just the same as those left in the field. The stalks should be fed in such a way as to avoid the necessity for clean-up work of this type

or the construction of a silo. (Fig. 9.) The amount of labor required for the use of the husker-shredder is about the same as for husking the corn from the shock. The use of the husker-shredder, when combined with low cutting, has the advantage of completely disposing of practically all of the borers, thereby avoiding the necessity for other more laborious means of control.

WHEN TO DO CONTROL WORK

The time of the year when corn-borer clean-up operations may be performed to best advantage is almost as important to farmers as is the amount of this work to be done. As much of this extra work as possible should be done before the rush of spring work begins.

The effort to reduce the amount of labor necessary during the spring should begin as early as September of the previous fall. If the corn for the silo is cut as low as 2 inches, all the borers that are in such corn are killed, either by the silage cutter or by the acids formed after filling the silo. It is probably even more important to cut the corn low in October because the borers work downward in the stalk late in the season.

If the stubble beater is to be used on land that is to be sown to wheat in the fall, it should be used in September or October, provided the stubble is not over 10 inches long and provided the other conditions for the use of this machine are satisfactory. The use of a low-cutting binder will usually be more satisfactory.

Besides plowing under as much corn-stubble ground as possible in the fall, it should be advantageous to plow part of the corn ground on which the corn has been harvested from the standing stalks. This can be done in seasons which are favorable for plowing, during the latter part of November and the first part of December, if the corn husking is out of the way. If the cornland that is to go into spring grains is harvested first, and is pastured while the rest of the corn harvest is being completed, it often is possible to get this much plowing done late in the fall if the season is favorable. This is especially important on soils that can not be plowed in the spring and worked down into a satisfactory seed bed in time to seed small grain.

FIG. 9.—The use of the husker-shredder combined with low cutting is an effective means of destroying corn borers and eliminating the necessity for other control operations

In January or February the standing stalks may be broken off with a T rail or pole, if there is a period during that time when the ground is frozen and free of snow. If the stalks are frozen dry they may also be raked and burned at this time. This will reduce considerably the amount of clean-up work to be done later in the spring. Any bright, dry weather in winter should be utilized in destroying cobs and trash, especially cornstalks, around the barns and feed lots.

During the last of March, or early in April, the cornstalks that have not been destroyed during the winter should be raked and burned. Plowing for spring grain should be done early in the spring—in March if possible. If land is not to be plowed, a part of the hand picking may also be done at this time.

During April most of the disking, harrowing, seeding, and rolling is usually done. In cases in which the land is plowed it is more advantageous to do any unavoidable hand picking after the ground

is seeded. During the last half of the month the cornstalks on land that is to be fitted for corn again may be broken or cut off, raked, and burned, if weather conditions during the winter have made it impracticable to do it before that time. The hand picking of stalks and trash on the surface, after seeding or planting, should be done when the weather is favorable for burning, and so far as possible it should be sandwiched in between other field operations during this month.

CONTROL-WORK CALENDAR

September	Cut corn low for silage.
October	Cut corn low for shredding or shock feeding.
November	Harvest standing corn.
	Plow corn-stubble ground, where practicable.
	Shred corn fodder.
December	Plow early harvested stalk ground if weather permits.
	Shed corn fodder.
January and February	Break standing stalks if no snow.
	Rake and burn stalks if frozen dry.
	Destroy cobs and trash around barns and feed lots.
March	Rake and burn stalks if not already done.
	Do early spring plowing.
April	Disk for small grain.
	Harrow.
	Seed small grain.
	Hand pick and burn after seeding if necessary.
	Rake and burn stalks on corn ground.
	Plow for corn.
	Disk corn ground.
	Destroy cobs and trash around barns and feed lots.
May	Harrow corn ground.
	Roll corn ground.
	Plant corn.
	Hand pick stalks and trash after planting if necessary.

CHANGES IN CROPPING SYSTEMS

The actual damage to the corn crop in the eastern Corn Belt of the United States has been limited to such small acreages that no pronounced shift from corn to other crops has occurred. In the Canadian areas where the infestation and damage have been heavy there has been a marked shift from corn to such crops as oats, barley, wheat, peas, beans, hay, sugar beets, and tobacco. In some localities over half the corn has been displaced by these crops.

Many farmers in the infested areas of Ohio and Michigan, and in adjacent areas, are faced with the question as to whether the necessity for adopting control practices and the possibility of reduction in the yield of corn may make it desirable for them to replace a part of the corn acreage with other crops.

The answer to this question depends mainly on two things: (1) The advantage of corn over other crops either as a feed crop or as a crop for sale, and (2) the ease or difficulty with which methods of corn production may be modified so as to keep down the borer infestation and avoid serious commercial damage.

The general adoption of practicable methods of control such as have been outlined in the preceding pages should prevent serious damage to the corn crop and obviate the necessity for any general replacement of corn with other crops.

Such changes as were made in crops grown in the infested areas of Ohio and Michigan in 1927 were due almost entirely to the increased amount of labor and power needed in growing corn under corn-borer control regulations then in force and to fear of future borer damage, rather than to actual damage by the borer. Another factor of importance, in some areas, was the prospective reduction in yields of oats or other crops, following corn, on account of changes in methods of preparing cornland for the next crop. This was especially important in localities in which the soil is very difficult to handle when cornland is plowed in the spring for a small-grain crop.

In northeastern Ohio and east-central Michigan the adoption of control practices requires only minor adaptation of the present practices on most farms. If these practices prove to be effective in keeping the infestation below the point of important commercial damage, farmers no doubt will find it more advantageous to follow these practices than to turn to other crops which produce less revenue or

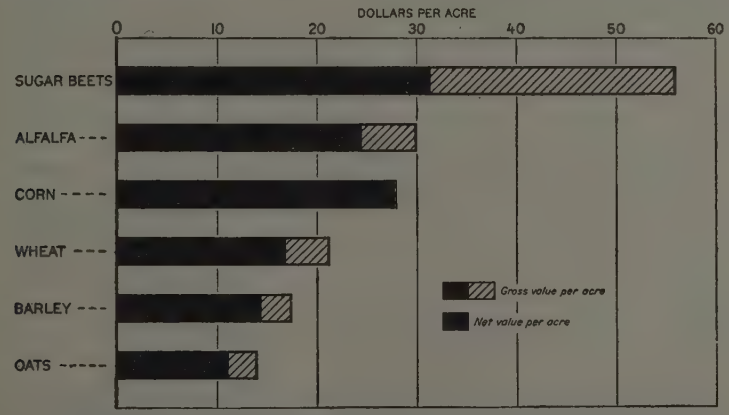

FIG. 10.—Average gross and net values per acre of corn and alternative crops, northwestern Ohio and southeastern Michigan. (The net value is the gross value after deducting cash costs.) The small-grain crops—wheat, oats, and barley—do not compare favorably with corn from the standpoint of value per acre

less feed per acre than does corn. This is especially true on those farms where the corn is put into the silo or is shredded.

The farmers in other sections of the infested area are more interested in a possible shift of a part of the corn acreage to other crops. The larger acreages of corn per farm, the necessity for new operations involving additional labor and power for corn production, the fact that only a part of the cornstalks are now used for feed, and the difficulties encountered in some localities in plowing cornland in the spring for a small-grain crop, all combine to make this problem more important in those sections.

The crops most commonly grown in the area are naturally the ones to which farmers would give attention when considering possible changes in their farming systems. Oats, wheat, and mixed clover and timothy hay are the only crops which now occupy an acreage comparable with corn in the present infested area. If the borer

infestation should increase to the point of causing serious commercial damage, these crops would no doubt be the first to be considered by most farmers as possible substitutes.

Sugar beets are grown to some extent in the northwestern Ohio and southeastern Michigan area and are a possible substitute crop, especially in localities where corn is grown primarily for sale rather than as a feed crop. Alfalfa hay is grown as a feed for dairy cows, and, to some extent, is grown for sale by limited numbers of farmers in all parts of the infested area. It should be considered as an alternative if the corn acreage is to be reduced. The acreage of barley grown in northwestern Ohio and southeastern Michigan was increased slightly in 1927, partly because of the corn borer. Barley may become more important on some farms as an alternative grain crop. Truck crops are grown in parts of the infested area, especially around the industrial centers along the lake.

The average yield of corn in much of the present infested area (especially in northwestern Ohio and southeastern Michigan) is approximately 40 bushels an acre. From the standpoint of average yields and average prices, sugar beets and alfalfa are the only crops now commonly grown on general farms in the infested areas which compare favorably with corn from the standpoint of gross value per acre. (Fig. 10.) The gross values per acre and the value after deducting actual cash outlays for the production of sugar beets, corn, alfalfa, wheat, and barley in northwestern Ohio and southeastern Michigan are about as follows:

	Gross value per acre	Value after actual cash outlays are deducted
Sugar beets	$56.00	$31.40
Corn	28.00	27.80
Alfalfa	30.00	24.50
Wheat	21.25	16.85
Barley	17.50	14.40
Oats	14.00	11.10

Sugar beets compare more favorably with corn as a revenue producer than does any crop now grown to a considerable extent in the area that comprises northwestern Ohio, northeastern Indiana, and southeastern Michigan. Information obtained from farmers in this area, in the summer of 1927, indicates a slight tendency to shift a part of the corn acreage to sugar beets. As sugar beets must be cultivated, the crop fits well into the usual crop rotation in this area. Aside from the contract labor and that of hauling the beets to the factory or shipping station, the labor on sugar beets does not differ greatly from that used on corn, either as to the amount of work or the time when the work must be done.

Before substituting sugar beets for all or a part of the corn acreage, however, a farmer must consider the adaptability of his soil to sugar beets, the marketing facilities and market outlets available, and the cost of hauling beets to the factory or shipping station. Where all of the corn and stalks are utilized for feed, the substitution of sugar beets will necessitate the purchase of more feed or the reduction of the livestock enterprises. In addition, the labor problems involved in sugar-beet production are usually more difficult than in the case of corn or the small-grain crops.

In considering an alternative like alfalfa, as a crop for sale in the place of corn, it must be recognized that any pronounced increase in the acreage of alfalfa grown for sale might make it necessary to ship to more distant markets, with resulting lower prices to the farmers in this area. Increased acreage of oats, barley, wheat, and sugar beets would not have any marked effect upon their prices until a much larger territory is affected.

Neither of the small-grain crops, wheat or oats, now extensively grown in the infested area in rotation with corn, compares favorably with corn as a revenue producer. Wheat compares more favorably than oats from the standpoint of value per acre, but in the cash-grain area of northwestern Ohio and northeastern Indiana oats are grown more extensively after corn than is wheat because of the difficulty of seeding winter wheat in the fall after corn, and the frequent winter killing.

Oats and barley are the other grain crops usually mentioned as possible substitutes for corn as feed grains. Considering average yields in the infested area of northwestern Ohio and southeastern Michigan, the bushels and pounds of grain grown per acre of these crops are about as follows:

	Bushels per acre	Pounds per acre
Corn	40	2, 240
Barley	25	1, 200
Oats	35	1, 120

The additional pounds of corn grown per acre are sufficient to indicate the superiority of corn as a feed crop in this area, although it is possible that the yields of oats and barley would be increased by the use of better yielding varieties and the adoption of better cultural methods.

Because of the smaller amount of feed grown per acre the extensive substitution of oats or barley for corn, on farms where practically all of the corn is used for feed, would make it necessary to reduce the number of livestock or purchase additional feed or enlarge the area of grain crops grown for feed.

The disadvantage of the small-grain crops as compared with corn, from the standpoint of feed produced per acre or net value per acre, is partly offset by the smaller amount of labor ordinarily used in small-grain production and the fact that they are harvested early, which gives more time in the fall for seed-bed preparation and other fall work. Corn ordinarily requires almost twice as much labor per acre for its production as do the small-grain crops. The labor on corn, however, is distributed fairly evenly throughout the year, whereas that on small-grain crops is concentrated during the two very busy seasons of seeding and harvest. Consequently more labor must ordinarily be hired for the work on small-grain crops than for the work on corn, which can usually be done without additional expense for hired labor.

The small-grain crops in this area are now grown almost entirely in rotation with corn and with only a limited amount of time devoted to the preparation of a special seed bed. Any pronounced increase in the acreage of small-grain crops at the expense of corn would result in the necessity for more plowing if two or more small-grain crops are grown in succession. It would also increase the amount

of work to be done during the rush season of small-grain harvest in the summer.

In most of the infested area the size of farms is influenced to a considerable extent by the acreage of corn which a farmer can handle with a given labor supply or with one set of tools for cultivating or harvesting. In such cases substantial changes in corn acreage, or the extensive substitution of small-grain crops for corn, may involve corresponding adjustments in the size of farms. Changes of this type usually come about very slowly and should await developments with respect to commercial damage by the borer and the effectiveness of control practices which may be incorporated with present production practices without adding materially to the actual cash expense of farm operation.

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January 20, 1928

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